NON-PUBLIC?: N
ACCESSION #: 9409150161
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Oconee Nuclear Station, Unit 3 PAGE: 1 OF 11

DOCKET NUMBER: 05000287

TITLE: Reactor Trip From Blown Control System Fuse Due To An Unknown Cause
EVENT DATE: 08/10/94 LER #: 94-02-00 REPORT DATE: 09/08/94

OTHER FACILITIES INVOLVED: DOCKET NO: 05000

OPERATING MODE: N POWER LEVEL: 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
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COMPONENT FAILURE DESCRIPTION:
CAUSE: F SYSTEM: EJ COMPONENT: INVT MANUFACTURER: E353
REPORTABLE NPRDS: YES

SUPPLEMENTAL REPORT EXPECTED: No

ABSTRACT:

On August 10, 1994, at 0426 hours, while operating at 100% full power, Unit 3 tripped as a result of a momentary loss of power to the Integrated Control System inverter, 3KI. Operators observed an overcooling of the Reactor Coolant System and also noted a diverging pressure trend between 3A and 3B Steam Generators (S/G) and suspected a leak or rupture of the 3B main Steam header. They isolated the 3B S/G, then noted that the Turbine Bypass Control valves (TBVs) were partially open and closed them. The open TBVs had caused the overcooling and depressurization of the S/Gs. The Unit was then stabilized at Hot Shutdown condition with decay heat removal via 3A S/G. The event was terminated when the 3B S/G was unisolated, refilled, and pressurized. The cause of the event was determined to be blown fuses on 3KI inverter, but the root cause of the blown fuses is unknown. Corrective actions included the continuation of troubleshooting the problems with the inverter and modification to the TBVs controls.

END OF ABSTRACT

BACKGROUND

The Integrated Control System (ICS) EIIS:JA! Power Supply is composed of a 125 VDC isolating transfer diode assembly, (3ADF), a static inverter, (3KI), a backup transfer switch, (ASCO), an external inverter bypass, an isolation transformer, and panelboard (see attachment 1). The static inverter unit consists of a static inverter, a static transfer switch, and an internal manual bypass switch. The external inverter bypass unit consists of three breakers. The output of the inverter is synchronized with the AC Regulated Power System through the static switch to minimize transfer time from the inverter to the alternate supply. A backup transfer switch is provided for automatic transfer of system loads to the alternate power source should the inverter and static transfer switch become unavailable.

The 3KI inverter is a non-safety related power source that supplies essential (non-vital) plant loads. One of the primary loads that it supplies is the ICS and its various components. Essential plant parameters necessary for shutdown have been arranged with their power supplies independent of the ICS source. If a loss of ICS power occurs, the power supplies are designed to place the Unit in a known safe state by initiating a trip of both Main Feedwater EIIS:SJ! pumps (MFDWP) by a failsafe design of the Once Through Steam Generator (S/G) high level monitoring circuits. These circuits are designed such that upon loss of either "hand" or "auto" power to the ICS, they will initiate a trip of the MFDWPs and the Main Turbine simultaneously and also the reactor by an Anticipatory Reactor trip signal.

The Regulated Power System is a 120/240 VAC, single-phase power system that serves as a backup power for the loads powered by the Essential EIIS:EI! and the Vital EIIS:EJ! Power System. The Regulated Power System is powered from non load-shed 600v motor control centers and is required by Technical Specifications to be operable if the reactor is above 200 degrees F.

Emergency Feedwater System (EFDW) EIIS:BA! will actuate on loss of both Main Feedwater Pumps and its controls are independent of the ICS.

Stresses to the tubes of the once Through Steam Generators are in the form of tensile (Tubes cooler than Shell) and compressive (Shell cooler than Tubes) with limits in the form of delta temperature (delta T) for

each. The tensile limit is 100 degrees delta T and the compressive limit is 60 degrees delta T.

EVENT DESCRIPTION

At the time this event occurred, Unit 3 was operating at 100 k full power with all Integrated Control System (ICS) stations in automatic. No testing or major evolutions were in progress. Reactor Coolant System (RCS)

EIIS;AB! average temperature was approximately 579 degrees F and RCS pressure was approximately 2155 psig. The most recent Dose Equivalent Iodine (DEI) sample of the RCS was 0.25 uci/ml which-was abnormally high, but is consistent with the level for the current fuel cycle.

On August 10, 1994, at 0426 hours, Unit 3 tripped as a result of a momentary loss of power to the Integrated Control System (ICS) inverter, 3KI. Both the 3KI inverter input power fuse and static transfer switch alternate source fuses blew. After approximately 1.0 second time delay, the ASCO switch transferred to AC line, which re-energized panelboard 3KI from its alternate power source.

Emergency high 3A and 3B Steam Generator (S/G) level relays are powered from 3KI and, on a loss of power, these relays are designed to trip the Main Feedwater Pumps (MFDWPs) and the Main Turbine. The indicated Emergency high S/G level tripped MFDWPs 3A and 3B and the Main Turbine which caused an anticipatory Reactor trip. Emergency Feedwater (EFDW) automatically actuated with all three pumps starting and feeding the S/Gs as expected.

In response to the Reactor trip, the Operators entered the Emergency Operating Procedure (EOP) and initially the post trip response appeared normal. The Operators started 3A High Pressure Injection EIIS:BG! (HPI) pump at 0427:13 hours to provide additional makeup to the RCS. Approximately three minutes after the trip, the Operators observed an overcooling of the RCS and started 3C HPI pump (an additional makeup pump). They also noted a diverging pressure trend (150-200 psid) between 3A and 3B S/G and suspected a leak or rupture of the 3B S/G Main Steam header. They started isolating the 3B S/G and transferred to the Excessive Heat Transfer section of the EOP. During the isolation of 3B S/G, they noted that the Turbine Bypass Control valves (TBVs) for 3B S/G were opened approximately 20% and took them closed at 0433 hours. The 3B S/G pressure was approximately 550 psig at this time. The 3C HPI pump was operated from 0429:34 to 0431:35 hours to maintain Pressurizer

EIIS:PZR! level. The 3A HPI pump was stopped at 0442:34 hours. The Unit was then stabilized at Hot Shutdown conditions. Decay heat removal was via forced RCS flow with the 3A S/G supplied by EFDW.

Most of the post-trip parameters remained within acceptable limits; however, the response of several components was specifically affected due to the momentary loss of 3KI. All control rod breakers opened as required and all control rods EIIS:ROD! dropped into the core, shutting down the reactor. RCS average temperature decreased from 579 degrees F to 524 degrees F and was stabilized at approximately 535 degrees F. Pressurizer level decreased from about 220 inches to a minimum of 29 inches prior to being stabilized at approximately 150 inches. As the RCS temperature and Pressurizer level decreased, likewise the RCS pressure also decreased from a normal pressure of approximately 2155 psig to a minimum of 1720 psig and then stabilized at approximately 2155 psig. Pressurizer level and RCS temperature and pressure post trip responses were abnormal due to the overcooling effect of the TBVs reenergizing to a partially open position in

manual. S/G levels dropped from 185/193 inches (S/Gs 3A and 3B, respectively) before the trip to a minimum of 28/6 inches after the trip. S/G 3A level was being maintained by EFDW and S/G 3B-post trip response was due to the Operators isolating it because of the suspected steam line rupture. S/G pressures were approximately 900 psig prior to the trip and then ranged from a high of 1104 psig (3A) and 1102 psig (3B) to lows oil 782 and 553 psig, respectively for 3A and 3B. The pressure in 3A and 3B S/Gs stopped decreasing when the Operator closed the TBVs.

An Unusual Event (NOUE) was declared at 0457 hours due to Secondary Side depressurization which required entry into the EOP Excessive Heat Transfer section. At 0459 hours the Oconee and Pickens County Law Enforcement Centers and the State Warning Point notification were initiated and were completed at 0513 hours. The NRC was notified at 0513 hours. The NOUE was terminated at 1337 hours when the 3B S/G was unisolated, refilled, and pressurized per the EOP direction for feeding a dry S/G. This was performed after determining that there was no leak or rupture to the S/Gs or the Main Steam lines.

Immediately following the Reactor trip an investigation was started which revealed that a momentary loss of 3KI power panelboard had occurred.

During the loss and subsequent re-energizing of 3KI, when the TBVs were re-powered, 3B S/G valves were open approximately 22% and 3A S/G valves were at 11%. The design of the TBVs controls is such that, following a

return to power, the Static Analog Memory Module will randomly position the valves. It was also concluded by the post trip review team that the dive
ging S/G pressure post trip was caused by the opening of the TBVs after 3KI panelboard was re-powered.

The Operating crew was making preparations to re-feed the isolated 3B S/G when it became apparent that this would not be completed prior to the shift change that was imminent. As the shift change was taking place, further discussion of the post-trip transient took place among Station management; the NRC Residents participated in a portion of this. Because of the high reactor coolant system activity existing on Unit 3 prior to the trip, it was decided it would be prudent to reconfirm the integrity of the 3B S/G before unisolating it. Pending this confirmation, management instructed the operating crew to delay re-feeding unless shell side pressure began decreasing substantially.

At a point in the discussions mentioned above, some of the involved personnel got the impression the NRC took the position that the 3B S/G should not be fed without their prior concurrence. When the Resident realized that this impression had been given, he promptly clarified that the licensee has the authority to decide on actions to cope with plant transients. The NRC did request a conference call including Oconee site management, NRC Region management, NRR staff, and Oconee's NRC Residents to brief them on the event. This call was arranged for.1000 hours. In the conference call, Station management explained the trip and transient,

described the assessment of the S/G integrity, and discussed the post-trip review restart issues.

At 1005 hours, the indicated compressive tube-to-shell delta temperature (T) limit for 3B S/G was exceeded (60 degree delta T limit) and continued to increase until a maximum delta T of 82 degrees was indicated at approximately 1205 hours. This indicated maximum of 22 degrees F over the limit for the approximately 2 hour duration was analyzed based on S/G and RCS temperature and pressure data recorded for this event. The analysis showed the S/G integrity was not compromised. The Operating crew was unaware of the compressive delta T limit and the limit was not included in the EOP. operations staff personnel that had some knowledge of the compressive limit became involved after the limit had been exceeded.

Operations Management gave instructions to the operating crew at approximately 1115 hours to continue with the EOP and reestablish feed to

the 3B S/G. Operations was attempting to place a MFDWP back in service but were having control problems with the steam supply valve. After some attempts to resolve this problem and because of concerns for the delta T limit, operations decided to utilize the EFDW system (one of the options allowed by the procedure). This was begun at approximately 1205 hours and completed at approximately 1330 hours. After the 3B S/G was re-fed using the instructions in the EOP, the shell to tube delta T returned to normal values. The Main Feedwater System was returned to normal and the EFDW system was shutdown. The Unit was then maintained at normal Hot Shutdown conditions.

The Plant Operation Review Committee (PORC) was convened at approximately 1300 hours to review the status of the trip recovery. Five issues/problems needing resolution prior to restart were identified:

1) RCS activity spiked to 3.94 uci/ml post trip and since the operating value for Unit 3 was already abnormal, Reactor Engineering recommended that the activity be < 1.0 uci/ml prior to restart.

2) 3B S/G delta T limit-had been exceeded and the dryout consequences, if any, needed resolution prior to restart.

3) motor operated valve 3MS-26 (3B S/G TBV Block) had problems with position indication in the control room following the trip when the Operators closed it.

4) The operation of the TBVs on repowering needed resolution.

5) The 3KI inverter had momentarily lost power, initiating the event. The cause of the blown fuses required investigation, and further operation of the 3KI inverter required evaluation.

The next day, August 11, 1994, the PORC reconvened in the morning to review the latest status of the re-start issues and they were as follows:

1) The latest RCS activity was now < 1.0 uci/ml and with the additional periodic chemistry sampling during startup, and limiting power increases to 5 % per hour, the high RCS activity was decided not to be a concern relative to re-start.

2) The modifications to the TBVs were presently being implemented on Unit's 1 and 2 and was ready to be implemented on Unit 3 after return to power (TBVs would not be in use).

3) A work request had been completed for 3MS-26; the valve cycled with no problems noted.

4) The analysis from B&W Nuclear Technologies concerning the exceeding of the shell compressive delta T limit of 60 degrees had been completed and it confirmed the integrity of the 3B S/G.

5) Troubleshooting of the 3KI inverter still did not come to a resolution of the failure mechanism. The agreed upon course of actions as they related to re-start were as follows:

a) Proceed with restart with the 3KI panelboard powered from AC line.

b) Continue troubleshooting the 3KI inverter. Consider options for returning inverter to service.

c) The PORC would revisit the issue of the status of 3KI inverter by November 1, 1994.

d) Operations was to "white tag" the inverter so that total consensus of management will be required prior to placing it back to its normal lineup.

This resolved all the issues satisfactorily with the Reactor Trip Recovery procedure and the procedure was completed at 1135 hours on August 11, 1994. The Unit was taken critical at 1326 hours and the generator placed on line at 1722 hours on August 11, 1994.

Unit 3 was restarted with the 3KI panelboard being powered from AC line as troubleshooting continued on the inverter. Placing KI panelboard on AC line is an acceptable practice on all the Oconee units. The AC line source of power is from the Regulated Power Supply System. The operation in this mode is covered by procedure and is not prohibited by Technical Specifications nor are there any unreviewed safety concerns.

A minor modification has been implemented on all three Units which replaced the Bailey Static Analog Memory Modules with Sega Static Analog Memory

Modules. These are preset to provide a closed TBV position should a loss and subsequent restoration of power to KI inverter occur. The

modification to the TBVs on Unit 3 was completed on August 13, 1994. Unit 1 and Unit 2 modifications to the TBVs were completed on August 11, 1994.

The failure of 3KI inverter is NPRDS reportable. The manufacturer is Exide and the manufacturing code number is E353, Model 120/93F1.

Conclusions

The cause of the Reactor trip was the momentary loss of power to the 3KI inverter which tripped the Main Feedwater pumps by design, thus leading to a reactor anticipatory trip. The inverter power fuse and the static switch AC line fuses were found blown following the trip. This indicated that a momentary loss or reduction in inverter output voltage caused the inverter static switch to transfer to AC line. Since the inverter loss of voltage was momentary, the static switch attempted to retransfer to the inverter, causing the inverter power fuse and the static switch AC line fuse to blow. The cause of the reduction in output voltage is not known. The momentary loss of power was caused by a failure of the 3KI inverter causing fuses to blow in the inverter and the static switch. The root cause of the 3KI inverter failure has not been determined. During troubleshooting it was demonstrated that the inverter still blew fuses while separated from plant loads. Troubleshooting the inverter has been extensive and is continuing while the 3KI panelboard is being powered from AC line. Therefore, the root cause of this event is Unknown.

The compressive tube-to-shell delta temperature (T) limit of 60 degrees F was exceeded because of delays in reestablishing the FDW supply to the S/G. These delays occurred, in part, due to a lack of urgency because the limit was not addressed in the Emergency Operating Procedure (EOP) and the involved operators and management were not aware it existed. They believed they were in a stable condition. Therefore, they did not expedite the decisions and actions that could have prevented exceeding the limit.

The decision to exclude this limit from the EOP was a conscious decision by procedure writers and reviewers. This decision was based on the fact that no scenario was foreseen that would challenge the limit, provided that the guidance in the EOP was followed in a timely manner. An extended delay in restoring FDW to a dry S/G was not anticipated during the development of the EOP. Therefore, it was considered unnecessary to document the limit in the EOP.

A review of events over the previous two years indicates that this is a recurring event. LER 287/92-03 and LER 270/93-01 both involve incidents

where there was a momentary loss of power to the KI inverter and resulted in a Reactor trip and a manual Reactor Protective System EIIS:JC! actuation, respectively. The root causes of the past events were determined. The corrective action from the previous events concentrated on the replacement of the inverters since the present ones are obsolete. The

inverters on Unit 1 have been replaced and the ones for Unit 2 are scheduled for replacement during its upcoming refueling outage in October 1994. Replacement of Unit 3 inverters is scheduled for its next refueling in mid 1995. Meanwhile, the 3KI panelboard is being powered from AC line and is performing satisfactorily.

There were no personnel injuries, radiation overexposures, or releases of radioactive materials associated with this event.

Corrective Actions

Immediate Corrective Actions

1. Operations personnel took appropriate actions in accordance with the Emergency Operating Procedure and Abnormal Procedures: Loss of ain
Feedwater, Loss of KI Bus, and High Activity in the RCS.

2. Operators closed the Turbine Bypass valves stopping the depressurization of the Steam Generators.

Subsequent Corrective Actions

1. A modification to the Turbine Bypass Valves (TBV) controls was implemented on all three Oconee Units. The TBVs will go to a close/manual state when re-energized after a loss of power.

2. The problem with remote indication on 3MS-26 (Turbine Bypass Valve Block) was resolved.

3. Operational Guidance was issued to the operating crews and placed on the Turnover Sheets concerning the operation of the TBVs. Also, information was included explaining that the 3KI panelboard power source will be from AC line until the 3KI inverter is placed in service.

Planned Corrective Actions

1. Continue with the troubleshooting of the 3KI inverter to resolve the root cause of the problem.

2. Based on the results of the inverter troubleshooting, decide on a course of action pertaining to the operation with 3KI.

3. Replace 3KI with new inverter during next Unit 3 refueling outage.

4. Evaluate methods of communicating guidance on the compressive delta Temperature limits.

5. Review the Emergency Operating Procedure (EOP) general guidance and reevaluate any limits or other guidance which has not been incorporated into the EOP.

6. Revise training, procedures, etc. as needed to effectively assure appropriate personnel (including licensed operators) will be aware of items identified in number 4 and 5 above.

Safety Analysis

The Integrated Control System (ICS) power supply is arranged such that it is normally powered from a dedicated static inverter system, which receives a DC input from the Vital Instruments and Control batteries EIIS:EJ!, and is backed by an AC input from one of the plant's regulated non-load shed buses. Both automatic and manual transfer switching is provided to select between supplies.

In addition to the power supply reliability for the ICS, essential plant parameters necessary for Operators to control and monitor for shutdown have been arranged with their power supplies independent of the ICS source. Also, a "display group" has been developed and defined on the plant operator aid computer such that upon a loss of ICS power, the operator will have complete information on key primary and secondary system parameters. Emergency procedures have also been developed to designate alternate sources of information on key plant parameters if the computer is unavailable, thus assuring the operator can obtain sufficient systems information.

The worst case overcooling accident is a double-ended rupture of the main steam line from rated power conditions with offsite power available. At rated power, the Steam Generator (S/G) inventory is at its maximum, so that the subsequent blowdown will result in the greatest heat removal.

If a loss of offsite power was assumed, the heat transfer in the S/G would be less, due to the loss of forced flow and the loss of the main feedwater system. Therefore, these initial conditions results in the most rapid cooldown of the RCS. The worst case assumptions for the steam line break accident, in addition to no Operator action, is when ICS does not perform its design function of controlling feedwater on S/G level (approximately 135 percent feedwater assumed delivered to the effected S/G). The return to power peaks at approximately eight percent. The power excursion will be terminated by a strong negative Doppler coefficient effect alone, if no other protective reactor trips are actuated. The steam line break accident has been analyzed with several assumptions regarding ICS and Operation actions to isolate feedwater. The results show that the unit can successfully mitigate the transient. In this event, Operator action terminated the overcooling event by closing the Turbine Bypass Valves.

Another potential scenario from this event is the possibility of Turbine Bypass Valves for both S/Gs going full open (rather than 11 and 20 percent as occurred in this event). This would effectively represent a small line break on both S/Gs. In such a scenario, the initial transient is less severe than the double ended rupture discussed above, but the operator response could be to isolate both S/Gs, thus terminating primary to

secondary decay heat removal. Upon diagnosis of the problem, the TBVs would be closed and one or both S/Gs would be returned to service.

The fact that the established operating delta Temperature limit was exceeded during this event caused the issue of rupture of one or more S/G tubes to be discussed. B&W Nuclear Technologies performed an evaluation which concluded that there was no detrimental effect on the S/G tubes due to the temperatures observed during this event.

Therefore, the health and safety of the public was not affected by this event.

Figure "Attachment #1" omitted.

Duke Power Company J. W. HAMPTON
Oconee Nuclear Site Vice President

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DUKE POWER

September 8, 1994

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287
LER 287/94-02

Gentlemen:

Pursuant to 10 CFR 50.73 Sections (a)(1) and (d), attached is Licensee Event Report (LER) 287/94-02, concerning a reactor trip due to a momentary loss of 3KI inverter.

This report is being submitted in accordance with 10 CPR 50.73 (a)(2)(iv). This event is considered to be of no significance with respect to the health and safety of the public.

Very truly yours,

J. W. Hampton
Vice President

/ftr

Attachment

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